



LPC662AM/LPC662AI/LPC662I CMOS Dual Operational Amplifier

General Description

The LPC662 CMOS Dual operational amplifier is ideal for operation from a single supply. It is fully specified for operation from +5V to +15V and features rail-to-rail output swing in addition to an input common-mode range that includes ground. Performance limitations that have plagued CMOS amplifiers in the past are not a problem with this design. Input V_{OS} , drift, and broadband noise as well as voltage gain (into 100 k Ω and 5 k Ω) are all equal to or better than widely accepted bipolar equivalents, while the power supply requirement is less than 0.5 mW.

This chip is built with National's advanced Double-Poly Silicon-Gate CMOS process.

See the LPC660 datasheet for a Quad CMOS operational amplifier with these same features.

Applications

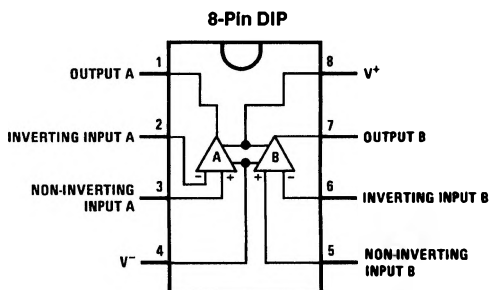
- High-impedance buffer
- Precision current-to-voltage converter
- Long-term integrator

- High-impedance preamplifier
- Active filter
- Sample-and-Hold circuit
- Peak detector

Features

- Rail-to-rail output swing
- Micropower operation (<0.5 mW)
- Specified for 100 k Ω and 5 k Ω loads
- High voltage gain 120 dB
- Low input offset voltage 3 mV max
- Low offset voltage drift 1.3 μ V/ $^{\circ}$ C
- Ultra low input bias current 40 fA
- Input common-mode includes GND
- Operation guaranteed from +5V to +15V
- Low distortion 0.01% at 1 kHz
- Slew rate 0.11 V/ μ s
- Insensitive to latch-up

Connection Diagram



TL/H/10548-1

Ordering Information

Package	Temperature Range		NSC Drawing
	Military	Industrial	
8-Pin Cavity DIP	LPC662AMD		D08C
8-Pin Small Outline		LPC662AIM or LPC662IM	M08A
8-Pin Molded DIP		LPC662AIN or LPC662IN	N08E

Absolute Maximum Ratings (Note 3)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Differential Input Voltage	$\pm$ Supply Voltage
Either Input beyond V^+ or V^-	0.7V
Supply Voltage ($V^+ - V^-$)	16V
Output Short Circuit to GND (Note 1)	Continuous
Lead Temperature (Soldering, 10 sec.)	260°C
Storage Temp. Range	-65°C to +150°C
Junction Temperature (Note 2)	150°C
ESD rating is to be determined.	

Operating Ratings

Temperature Range

LPC662AM

LPC662AI

LPC662I

Supply Range

 $-55^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$

4.75V to 15.5V

DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_A = T_J = 25^\circ\text{C}$. **Boldface** limits apply at the temperature extremes. $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{CM} = 1.5\text{V}$, $V_O = V^+/2$, and $R_L > 1\text{M}$ unless otherwise specified.

Parameter	Conditions	Typ	LPC662AM Limit (Note 4)	LPC662AI Limit (Note 4)	LPC662I Limit (Note 4)	Units
Input Offset Voltage		1	3	3	6	mV
			3.5	3.3	6.3	max
Input Offset Voltage Average Drift		1.3				$\mu\text{V}/^\circ\text{C}$
Input Bias Current	(Note 8)	0.04	20	20	20	pA
			100	4	4	max
Input Offset Current	(Note 8)	0.01	20	20	20	pA
			100	2	2	max
Input Resistance		> 1				Tera Ω
Common Mode Rejection Ratio	$0\text{V} \leq V_{CM} \leq 12.0\text{V}$ $V^+ = 15\text{V}$	83	70	70	63	dB
			68	68	61	min
Positive Power Supply Rejection Ratio	$5\text{V} \leq V^+ \leq 15\text{V}$ $V_O = 2.5\text{V}$	83	70	70	63	dB
			68	68	61	min
Negative Power Supply Rejection Ratio	$0\text{V} \leq V^- \leq -10\text{V}$	94	84	84	74	dB
			82	83	73	min
Input Common-Mode Voltage Range	$V^+ = 5\text{V}$ and 15V For CMRR $\geq 50\text{ dB}$	-0.4	-0.1	-0.1	-0.1	V
			0	0	0	max
		$V^+ - 1.9$	$V^+ - 2.3$	$V^+ - 2.3$	$V^+ - 2.3$	V
			$V^+ - 2.6$	$V^+ - 2.5$	$V^+ - 2.5$	min
Large Signal Voltage Gain	$R_L = 100\text{ k}\Omega$ (Note 5) Sourcing	1000	400	400	300	V/mV
			250	300	200	min
	Sinking	500	180	180	90	V/mV
			70	120	70	min
	$R_L = 5\text{ k}\Omega$ (Note 5) Sourcing	1000	200	200	100	V/mV
			150	160	80	min
	Sinking	250	100	100	50	V/mV
			35	60	40	min

DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_A = T_J = 25^\circ\text{C}$. **Boldface** limits apply at the temperature extremes. $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{CM} = 1.5\text{V}$, $V_O = V^+ / 2$, and $R_L > 1\text{M}$ unless otherwise specified. (Continued)

Parameter	Conditions	Typ	LPC662AM Limit (Note 4)	LPC662AI Limit (Note 4)	LPC662I Limit (Note 4)	Units
Output Swing	$V^+ = 5\text{V}$ $R_L = 100\text{ k}\Omega$ to $V^+ / 2$	4.987	4.970	4.970	4.940	V min
			4.950	4.950	4.910	
		0.004	0.030	0.030	0.060	V max
			0.050	0.050	0.090	
	$V^+ = 5\text{V}$ $R_L = 5\text{ k}\Omega$ to $V^+ / 2$	4.940	4.850	4.850	4.750	V min
			4.750	4.750	4.650	
		0.040	0.150	0.150	0.250	V max
			0.250	0.250	0.350	
	$V^+ = 15\text{V}$ $R_L = 100\text{ k}\Omega$ to $V^+ / 2$	14.970	14.920	14.920	14.880	V min
			14.880	14.880	14.820	
		0.007	0.030	0.030	0.060	V max
			0.050	0.050	0.090	
Output Current $V^+ = 5\text{V}$	Sourcing, $V_O = 0\text{V}$	22	16	16	13	mA min
			12	14	11	
	Sinking, $V_O = 5\text{V}$	21	16	16	13	mA min
			12	14	11	
Output Current $V^+ = 15\text{V}$	Sourcing, $V_O = 0\text{V}$	40	19	28	23	mA min
			19	25	20	
	Sinking, $V_O = 13\text{V}$	39	19	28	23	mA min
			19	24	19	
Supply Current	Both Amplifiers $V_O = 1.5\text{V}$	86	120	120	140	μA max
			145	140	160	

AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_A = T_J = 25^\circ\text{C}$. **Boldface** limits apply at the temperature extremes. $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{CM} = 1.5\text{V}$, $V_O = V^+/2$, and $R_L > 1\text{M}$ unless otherwise specified.

Parameter	Conditions	Typ	LPC662AM Limit (Note 4)	LPC662AI Limit (Note 4)	LPC662I Limit (Note 4)	Units
Slew Rate	(Note 6)	0.11	0.07	0.07	0.05	$\text{V}/\mu\text{s}$ min
			0.04	0.05	0.03	
Gain-Bandwidth Product		0.35				MHz
Phase Margin		50				Deg
Gain Margin		17				dB
Amp-to-Amp Isolation	(Note 7)	130				dB
Input Referred Voltage Noise	$F = 1\text{ kHz}$	42				$\text{nV}/\sqrt{\text{Hz}}$
Input Referred Current Noise	$F = 1\text{ kHz}$	0.0002				$\text{pA}/\sqrt{\text{Hz}}$
Total Harmonic Distortion	$F = 10\text{ kHz}$, $A_V = -10$ $R_L = 100\text{ k}\Omega$, $V_O = 8\text{ V}_{PP}$	0.01				%

Note 1: Applies to both single supply and split supply operation. Continuous short circuit operation at elevated ambient temperature and/or multiple Op Amp shorts can result in exceeding the maximum allowed junction temperature of 150°C .

Note 2: The junction-to-ambient thermal resistance of the molded plastic DIP (N) is $101^\circ\text{C}/\text{W}$, the molded plastic SO (M) package is $152^\circ\text{C}/\text{W}$, and the cavity DIP (D) package is $124^\circ\text{C}/\text{W}$. All numbers apply for packages soldered directly into a PC board.

Note 3: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed.

Note 4: These limits are guaranteed and are used in calculating outgoing AQL.

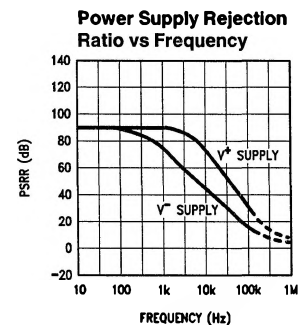
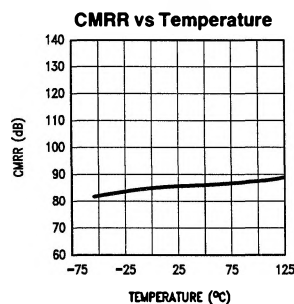
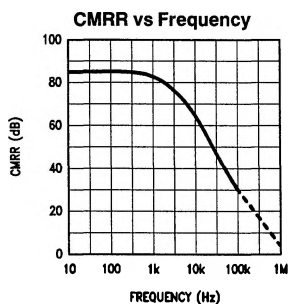
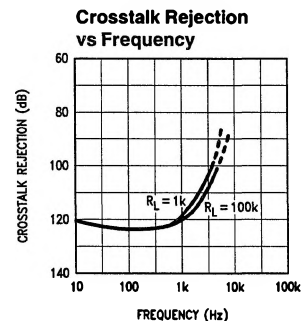
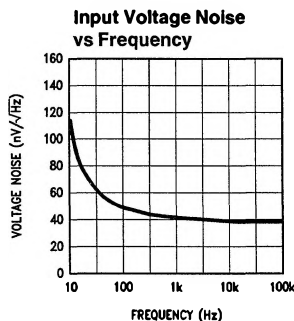
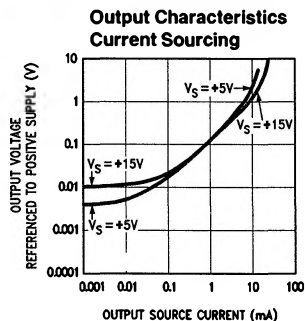
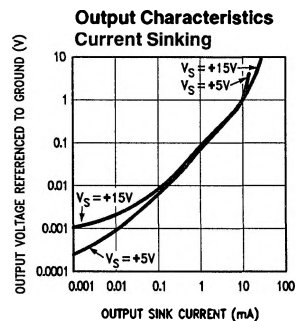
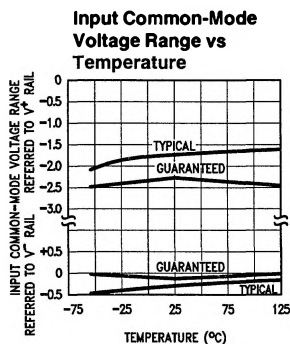
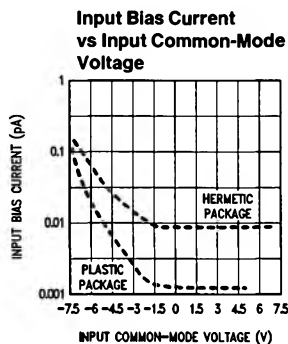
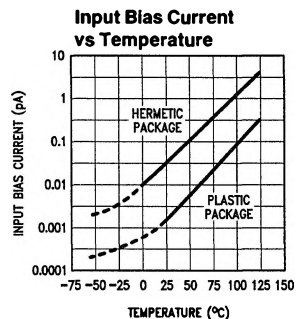
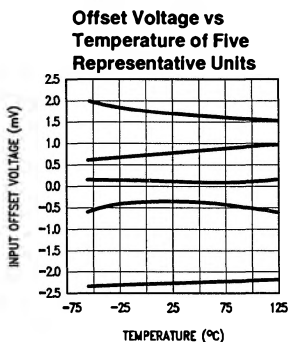
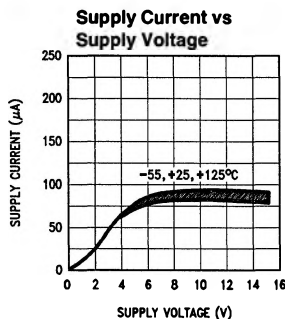
Note 5: $V^+ = 15\text{V}$, $V_{CM} = 7.5\text{V}$ and R_L connected to 7.5V . For Sourcing tests, $7.5\text{V} \leq V_O \leq 11.5\text{V}$. For Sinking tests, $2.5\text{V} \leq V_O \leq 7.5\text{V}$.

Note 6: $V^+ = 15\text{V}$. Connected as Voltage Follower with 10V step input. Number specified is the slower of the positive and negative slew rates.

Note 7: Input referred. $V^+ = 15\text{V}$ and $R_L = 100\text{ k}\Omega$ connected to $V^+/2$. Each amp excited in turn with 1 kHz to produce $V_O = 13\text{ V}_{PP}$.

Note 8: The LPC662AI and the LPC662I input bias current and input offset current specifications over the temperature range are guaranteed through correlation techniques; these numbers reflect the true performance of the part. All other input bias and offset current specifications (other than the typical) are measured; these numbers are degraded in order to reduce the test time (and the cost of the part) taken in measuring these parameters.

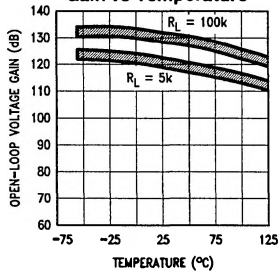
Typical Performance Characteristics $V_S = \pm 7.5V$, $T_A = 25^\circ C$ unless otherwise specified



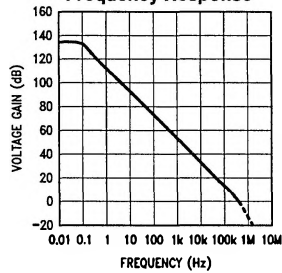
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Typical Performance Characteristics $V_S = \pm 7.5V$, $T_A = 25^\circ C$ unless otherwise specified (Continued)

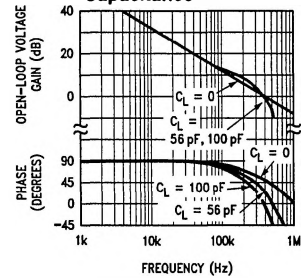
Open-Loop Voltage Gain vs Temperature



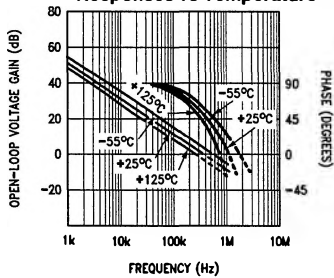
Open-Loop Frequency Response



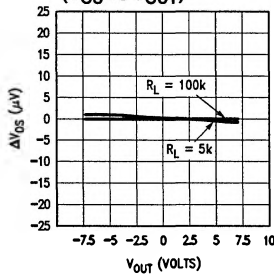
Gain and Phase Responses vs Load Capacitance



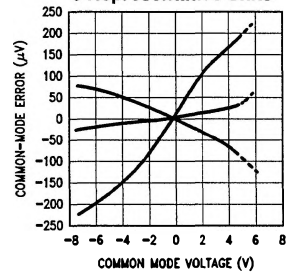
Gain and Phase Responses vs Temperature



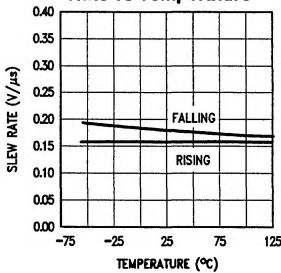
Gain Error (VOS vs VOUT)



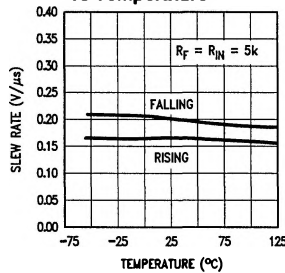
Common-Mode Error vs Common-Mode Voltage of 3 Representative Units



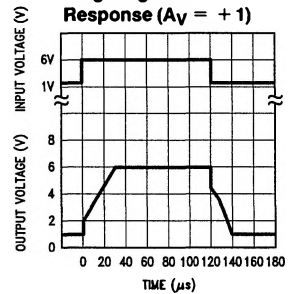
Non-Inverting Slew Rate vs Temperature



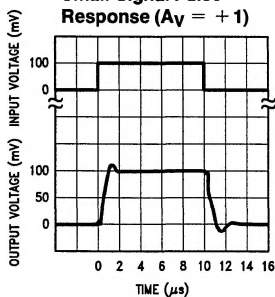
Inverting Slew Rate vs Temperature



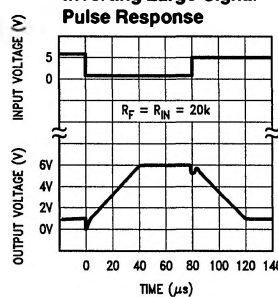
Non-Inverting Large-Signal Pulse Response (AV = +1)



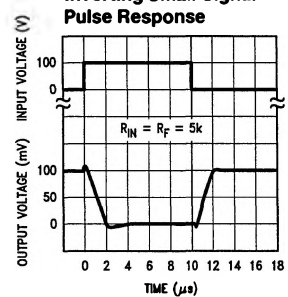
Non-Inverting Small-Signal Pulse Response (AV = +1)



Inverting Large-Signal Pulse Response

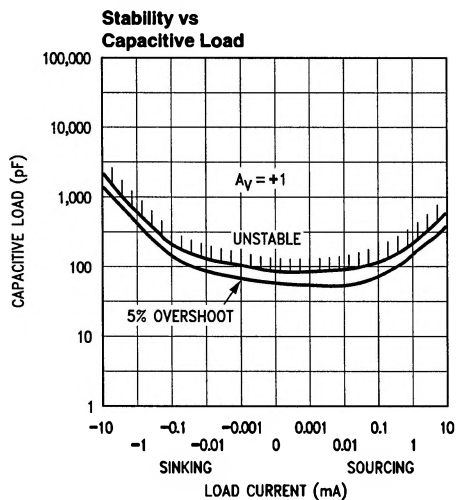


Inverting Small-Signal Pulse Response



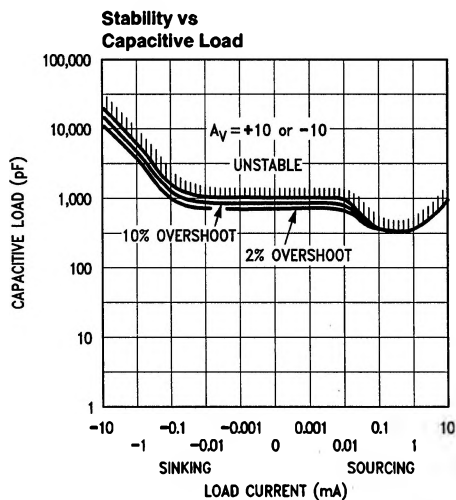
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Typical Performance Characteristics $V_S = \pm 7.5V$, $T_A = 25^\circ C$ (Continued)



TL/H/10548-4

Note: Avoid resistive loads of less than 500Ω , as they may cause instability.



TL/H/10548-5